Highlighting Student Voices: Perspectives on Active Learning Advanced Math Courses and Implications on Equity

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The relationship between active learning and equity is a prominent discussion within mathematics education, as it should be. There are conflicting findings on whether active learning promotes or detracts from equitable outcomes. This study aims to highlight student voices in describing the student experience in active learning advanced mathematics classrooms. This preliminary report outlines key themes that surfaced from a cursory analysis of the data; quiet students were seen as less confident or less competent by their peers during whole class discussions, and students were keenly aware of the knowledge distribution within small group discussions. It is important to understand the implications of the sociocultural dynamics that may be emphasized in active learning classrooms, thus being better equipped to attend to equity.

Keywords: active learning, inquiry-based learning, equity, advanced mathematics

It is understandable why advocates of student-centered, active learning instruction (e.g., inquiry-based learning) might purport active learning as means to achieve equity in mathematics education (Tang, 2017). Generally defined, active learning occurs in student-centered classrooms where students are actively engaged in doing mathematics during whole class discussions and collaborate with peers during small group discussions with the goal of building their own mathematical understanding; the instructor merely mediates student learning rather than acting as the sole intermediary of knowledge as is the case in traditional, lecture-based classrooms. As defined, active learning classrooms sound like idyllic classrooms in which equitable student outcomes are bound to occur. Clearly, if the best-case active learning classroom scenario were easy to employ *and* the norm, the answer to how to achieve equity in math classrooms would be more evident –simply implement active learning approaches. However, that is not the case. For the purposes of this preliminary report, my conception of equity focuses on how students position themselves and others in terms of equal access to participate *in* and *with* the mathematics, which is related to the assignment of competence (or power) and one's identity as a capable doer of mathematics (Gutiérrez 2002, 2013). Equity is an ideal that postsecondary mathematics educators strive for, but how we achieve this goal is elusive. There are some that report findings that active learning leads to equitable results, particularly for women (Freeman, 2014; Kogan and Laursen 2014; Laursen, 2014) and marginalized student populations (Fullilove and Treisman, 1990). On the other hand, others are more apprehensive or critical of the claim (Johnson et al., 2020; Ernest, 2019; Evans, 2022). These conflicting findings (and opinions) on the extent to which active learning achieves equitable student outcomes imply that more research is needed. The aim of this study is to highlight those most impacted by dramatic changes in teaching and learning practices, the students who experience learning in active learning classrooms. Much of the existing research on equitable implications of active learning centers around achievement results or learning outcomes, which are important when considering equitable outcomes. However, I believe that undergraduate students are equipped to articulate their perceptions of what works and what does *not* work for them in an active learning classroom. Furthermore, by highlighting student voices, the author answers the call to deepen our

field's understanding of the impact of active learning approaches on equity within undergraduate mathematics (Laursen & Rasmussen, 2019; Melhuish et al., 2022). In this preliminary report, I outline the methods used to conduct this qualitative study, describe a couple of significant connections between student responses that have equity implications, and discuss the equity implications.

Methods

The data in this study are comprised of semi-structured interviews (approximately an hour in length) with students who completed an advanced math course taught using an active learning approach. To provide readers with a basic context in interpreting the preliminary results, the self-reported demographics collected from each of the ten participants are presented in Table 1. Six participants were from an abstract algebra (Fall 2021) course and the remaining four participants were from an introduction to proof (Spring 2022) course. Both courses were offered at the same large, public Hispanic-serving university in the southern United States. The selection of the two different advanced math courses was intentional. It was discovered through the first round of interviews with the students from the abstract algebra course, that many of them had previously taken an active learning course. Therefore, the decision to recruit from an advanced math course earlier in the math course sequence seemed appropriate. As hoped, for variety, none of the four students from the introduction to proof course had previously taken an active learning course. Since the interviews took place after the end of the semester, interview questions were provided one to two days prior to the interview to allow adequate time for students to reflect on their experiences. The interview transcripts were generated using an electronic transcription service. Transcripts were verified for accuracy and any repeated words and filler utterances (e.g., uh, um). For preliminary analysis, a single coder open-coded broad interpretations of students' descriptions of firsthand and secondhand experiences in students' respective classes. Codes were then grouped by theme and relationships between the themes were identified. In total, there were 20 questions asked during each interview. For the purposes of this preliminary report, the focus will be on the following subset of questions that are strongly relevant to equity: *Do you believe you had equal access to participate in the course during whole class discussion as your fellow peers? Why or why not?; Do you believe each student (other than yourself) had equal access to participate in the course during whole class discussion? Why or why not?; Do you believe you had equal access to participate in the course during groupwork as your fellow peers? Why or why not?; Do you believe each student (other than yourself) had equal access to participate in the course during groupwork? Why or why not?*

Table 1. Self-reported student demographics

Identifier	Gender	Race/Ethnicity	Degree Program
Rosie	Female	White	Applied Mathematics
Tyler	Male	White	Education; MS Certification
Stephen	Male	White	Mathematics
Nathan	Male	Caucasian	Manufacturing Engineering
Ivan	Male	Hispanic	Applied Mathematics
Jon	Male	Southeast Asian	Computer Science & Mathematics
Nora	Female	White/Hispanic	Mathematics with Teaching Certification
Mary	Female	White/Cuban	Mathematics
Lamar	Male	White	Mathematics
Carlos	Male	Hispanic	Economics

Preliminary Results

The presentation of the preliminary results will be segmented into two broad categories, Whole Class Discussion and Small Group Discussion, which were derived from the foci questions, as listed above. Relationships between codes surfaced from the interview questions related to whole class discussion and small group discussion. I briefly summarize a relationship finding within each broad category and provide support from the data.

Whole Class Discussion: "You Gotta Be Strong"

It is not unusual to have quiet students in any given mathematics classroom. In a lecture-based classroom, they may go unnoticed. However, it is more challenging to hide in an active-learning classroom due to whole class discussions being a focal mode of learning. In analyzing the data, the characteristics of shyness/quietness arose on multiple occasions whether it was someone acknowledging they were the quiet one in class (projected as a deficit), or someone stating that it was easy to identify the shy ones (also considered a deficit). How might this pertain to equity? A student's disposition for shyness was a reason for peers to redraw mathematical competence, or conversely, outspoken students were interpreted as having more competence. The following series of interview excerpts illustrate some social dynamics of vocal and less vocal students within an active learning environment. When Mary was asked whether she believed she had equal access to participate in the course during whole class discussion as fellow peers, she responded as such:

> Yeah, pretty much. I've never been a super talkative person in class. Um, like when it comes to talking to other people in the class one-on-one, I love doing that and I love working in groups where we're all just kind of putting our heads down, thinking about stuff. But then if you were talking about the part where [the instructor] would like ask for sort of ideas on what to do, I would let other people talk and usually I just watched them battle it out. Um, 'cause that was fun for me, but you know, I don't like to be the loudest person in the class or anything, but I do think I had equal access to participate. I just chose not to sometimes.

Participation in whole class discussions may take on different forms. Although instructors ought to challenge and encourage students to vocally contribute to whole class discussions, ultimately, students should have the autonomy to participate in ways that are comfortable to them. However, one trend that surfaced was the tendency to interpret shyness or quietness, a trait often attributed to women, as an indication of mathematical inability or lack of confidence.

> *Jon:* There tended to be those people who were bad at math, and I don't wanna say bad at math like that, but they weren't good at proofs. Like, they said it, it was relatively clear, you know, and those type of people tended to not talk as much.

Jon describes making a connection between math ability and quietness. However, Mary was content engaging, albeit quietly, in whole class discussions while actively participating in small group discussions. Her identity encapsulated a quiet demeanor, which is not a reflection of her mathematical ability as she suggests in the following excerpt.

> *Mary:* Um, I'm just comfortable not saying anything. I actually ended up talking to my really good friend that I made [from class] about this 'cause he said at some point during the semester." It's obvious that you know what's going on and you just prefer not to speak.' Yeah, that's true. It wasn't like, I was feeling like I didn't have equal access. I just kind of was like, I was chilling, you know?

Mary implies that there is a level of assertiveness and strength needed to participate in whole class discussion when she admits, "I didn't talk because I knew someone else was gonna answer,

but you know, you gotta be strong. You gotta stand up for yourself if you wanna. If you really want to talk, like you can just do it."

Many of the participants mentioned being able to identify the talkers from the non-talkers, and in fact, stated there were more non-talkers than talkers. In contrast to the negative labels non-talkers were ascribed, the more vocal students were assigned competence. Rosie admits being nervous to talk when there were outspoken people in class, whom she attributed competence due to their perceived confidence. This led her to doubt herself and her potential mathematical contribution.

> *Rosie:* Yeah. I feel like if I wanted to talk, like I definitely had like the opportunity and chance to. It was hard sometimes because we definitely had some more outspoken people in the class and it always made me nervous 'cause sometimes I got different answers than them on stuff, right? And they were very like sure in like what they were saying. So, it kind of made me like a little bit more hesitant to talk sometimes even though I was like, mmm, I don't know. But I'm also just a little bit more shy like that.

When asked a follow-up question related to whether the vocal student referred to earlier in the interview affected Nora's learning, Nora explained that it was helpful to have a different perspective than the professor.

> *Nora:* Not at all. Because I think we all also like learned from him like 'cause he was very vocal about like things that were going through his mind. Like um, if there was like a pattern going on through like a proof that we were learning, he would kind of vocalize it. So, I think it also at points like helped the class learn a little bit more and to see his point of view, like a little bit different than the professor's, because then we're getting kind of like multiple points of view. And so, at times it really helped.

The more vocal students have ascribed competence in contrast to less vocal students who have their mathematical proficiency questioned. Due to the focus on peer-to-peer interactions in active-learning classes, this is important to note. The perceptions of peer competence affect how students work together in small groups, which are prominent in active learning classrooms.

Small Group Discussion: "There was clearly a knowledge disparity"

As a characteristic of active learning classrooms, small group discussions were paramount in both courses within this study. In response to the series of questions asking about equal access to participate in the course during group work, Mario described an obvious "knowledge disparity" between the groups. When the interviewer asked Mario what he meant by "knowledge disparity," he responds:

> The best way I could put it is that you could tell that there's like a team that just really understood everything. And there were other teams that were just kinda like struggling. There were some groups that were kind of like in the middle, they kind of understood some of the stuff, and then there were some teams that were just like… 'I need outside help essentially.' The group assignment remained the same for this course the entire semester. Mario described how frustrating it was to be in a group where everyone was lost, and they had to wait for the professor to make it to their group to offer assistance.

He goes on to explain how difficult it was to get assistance if the entire group was lost due to "knowledge disparity."

> *Mario:* If you had questions or you were stuck, you're just like waiting for the professor to just kind of like come and help you. So, you know, if every team is like, kind of like

needing help on a part, you're kind of just like in this queue trying to solve it, you know, you kind of stall.

By design, active learning is meant to distribute mathematical authority more evenly rather than being solely held by the instructor. However, if an entire group is unable to make progress on a problem or proof, the group may have to rely on the instructor, as was the case described by Mario. Thus, the knowledge disparity persists. If you were fortunate to be with group members who had a stronger understanding of a concept, there were sentiments related to the uneven distribution of knowledge within a group.

> *Ivan:* There would be cases in which some of our other group members, they didn't really do as much because they were confused, or they were lost within the proof itself. So from there, what we would do is we would essentially guide one another and as to the right direction. And just to essentially give them the baby steps of other proofs to show them as a way to kind of help them to learn that proof per se, or topic.

But the consequences of leveraging your group members for instruction may lead to fellow group members feeling as Jon describes.

> *Jon:* There was an effort, but I mean at a certain point you kind of have to stop so that you can actually get the work done. So yeah. I mean, there's a limited time to finish. We had probably, I think at the entire semester, there was like a hundred proofs or something. So, I mean, there was quite a bit to do, and we cannot like hold back because of somebody.

Group members may feel as though they are being held back due to the time it takes to explain mathematics concepts to peers. This shift in authority that occurs in active learning environments is powerful as long as there is an accommodation made for situations as described by the students within this study.

Discussion

This study is a direct response to the call by many (e.g., Adiredja, 2017) for additional research on issues of equity in postsecondary education and, particularly, research that investigates student perceptions of their active learning experiences. The findings from this preliminary analysis indicate that competence may be assigned to students based on their perceived level of participation in whole class discussions. Furthermore, that assigned competence is likely to transfer into small group discussions and affect peer interactions. Additionally, students are perceptive to the unequal distribution of collective knowledge between *and* within small groups. As was stated, it was obvious whether someone was in a group that possessed "less" knowledge. These groups would have to wait around for the professor's assistance. In the case where there were more knowledgeable students in a group, the more knowledgeable students felt like they were being slowed by having to explain concepts to peers. It is speculated (Brown, 2018; Ernest et al., 2019; Johnson et al., 2020) that since active learning classes increase personal interactions through whole class and small group discussions, student beliefs and peer perceptions may play a more significant role in learning than in traditional lecture-based classrooms. Although instructors cannot eradicate stereotypes and beliefs students possess, instructors can take steps to mitigate the influence of these beliefs as long as we identify common student perceptions. It is imperative to understand the challenges of implementing active learning approaches to make necessary modifications or accommodations to simultaneously and consistently achieve equitable results.

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